Infections

Odontogenic infections are usually mild and easily treated and may only require the administration of an antibiotic. Conversely, odontogenic infections may be more complex and require an incision and drainage, or they may be complicated and require that the patient be admitted to the hospital. Some infections that occur in the oral cavity are preventable if the surgeon uses appropriate antibiotic prophylaxis. This section presents the principles of infection management and prevention in dental patients.

Chapter 15 describes the basic management techniques, including surgery and antibiotic administration, for the treatment of odontogenic infections. This chapter also discusses the principles of antibiotic prophylaxis for the prevention of both wound infection and distant metastatic infection, such as infectious endocarditis.

Chapter 16 presents an overview of complex odontogenic infections that involve fascial spaces and may require hospitalization of the patient for treatment. Osteomyelitis and other unusual infections are also discussed.

Chapter 17 presents the indications, rationale, and technical aspects of surgical endodontics. Although periapical surgery is occasionally necessary for successful endodontic management, it is necessary for the clinician to be wise in deciding when to choose this treatment modality. Therefore the discussion of the indications and contraindications for endodontic surgery is extensive, and the technical aspects of surgical endodontics are profusely illustrated.

Chapter 18 presents information about patients at risk for infection and other comprising problems that are caused by patient host defense compromise as the result of radiotherapy or cancer chemotherapy. These patients are susceptible to a variety of problems, and the prevention and management of these problems are discussed.

Chapter 19 describes maxillary sinus problems that arise secondary to odontogenic infections and other problems. Although general practitioners rarely see patients with these problems, they may have to provide diagnoses before referring these patients to the appropriate professional for definitive care.

Finally, Chapter 20 discusses salivary gland diseases, primarily the obstructive and infectious types. The major diagnostic and therapeutic modalities used in managing these problems are discussed.

Principles of Management and Prevention of Odontogenic Infections

CHAPTER

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CHAPTER OUTLINE

One of the most difficult problems to manage in dentistry is an odontogenic infection. These infections may range from low-grade, well-localized infections that require only minimal treatment to severe, life-threatening fascial space infections. Although the overwhelming majority of odontogenic infections are easily managed by minor surgical procedures and supportive medical therapy that includes antibiotic administration, the practitioner must constantly bear in mind that these infections occasionally become severe in a very short time.

This chapter is divided into several sections. The first section discusses the typical microbiology involved in odontogenic infections. Appropriate therapy of odonto-

genic infections depends on a clear understanding of the causative bacteria. The second section discusses the natural history of odontogenic infections. When infections occur, they may erode through bone and into the overlying soft tissue. Knowledge of the usual pathway of infection from the teeth and surrounding tissues through the bone and into the overlying soft tissue planes is essential when planning appropriate therapy. The third section of this chapter deals with the principles of management of odontogenic infections. A series of principles are discussed, with consideration of the microbiology and typical pathway of infection. The chapter concludes with a section on prophylaxis against infection. The prophylaxis of wound infection and of metastatic infection is discussed.

MICROBIOLOGY OF ODONTOGENIC INFECTIONS

The bacteria that cause infection are most commonly part of the indigenous bacteria that normally live on or in the host. Odontogenic infections are no exception, because the bacteria that cause odontogenic infections are part of the normal oral flora: those that comprise the bacteria of plaque, those found on the mucosal surfaces, and those found in the gingival sulcus. They are primarily aerobic gram-positive cocci, anaerobic gram-positive cocci, and anaerobic gram-negative rods. These bacteria cause a variety of common diseases, such as dental caries, gingivitis, and periodontitis. When these bacteria gain access to deeper underlying tissues, as through a necrotic dental pulp or through a deep periodontal pocket, they cause odontogenic infections.

Many carefully performed microbiologic studies of odontogenic infections have demonstrated the microbiologic composition of these infections. Several important factors must be noted. First, almost all odontogenic infections are caused by multiple bacteria. The polymicrobial nature of these infections makes it important that the clinician understand the variety of bacteria that are likely to cause the infection. In most odontogenic infections the laboratory can identify an average of five species of bacteria. It is not unusual for as many as eight different species to be identified in a given infection. On rare occasions a single species may be isolated.

A second important factor is the anaerobic-aerobic characteristic of the bacteria causing odontogenic infections. Because the mouth flora is a combination of aerobic and anaerobic bacteria, it is not surprising to find that most odontogenic infections have both anaerobic and aerobic bacteria. Infections caused by only aerobic bacteria probably account for 5% of all odontogenic infections. Infections caused by only anaerobic bacteria make up about 35% of the infections. Infections caused by both anaerobic and aerobic bacteria comprise about 60% of all odontogenic infections (Table 15-1).

The aerobic bacteria that cause odontogenic infections consist of many species (Table 15-2). The most common causative organisms are streptococci, which comprise about 90% of the aerobic bacterial species that cause odontogenic infections. Staphylococci account for about 5% of the aerobic bacteria, and many miscellaneous bacteria contribute 1% or less. Rarely found bacteria include group D *Streptococcus* organisms, *Neisseria* spp., *Corynebacterium* spp., and *Haemophilus* spp.

TABLE 15-1

Causative Organisms*

	Number of Patients	Percentage
Aerobic	28	7
Anaerobic only	133	33
Mixed	243	60

*In 404 patients; data from Aderhold L, Konthe H, Frenkel G: The bacteriology of dentogenous pyogenic infections, *Oral Surg* 52:583, 1981; Bartlett JG, O'Keefe P: The bacteriology of perimandibular space infections, *J Oral Surg* 50:130, 1980; Chow AW, Roser SM, Brady FA: Orofacial odontogenic infections, *Ann Intern Med* 88:392, 1978; Lewis MAO et al: Prevalence of penicillin resistant bacteria in acute suppurative oral infection, *J Antimicrob Chemother* 35B:785, 1995; McGowan DA: Is antibiotic prophylaxis required for dental patients with joint replacement? *Br Dent J* 158:336, 1985; Norden CW: Prevention of bone and joint infections, *Am J Med* 78:229, 1985.

TABLE 15-2

Microorganisms Causing Odontogenic Infections*

Organism	Percentage
Aerobic†	***25***
Gram-positive cocci	85
Streptococcus spp.	90
Streptococcus (group D) spp.	2
Staphylococcus spp.	6
Eikenella spp.	2
Gram-negative cocci (*Neisseria* spp.)	2
Gram-positive rods (*Corynebacterium* spp.)	3
Gram-negative rods (*Haemophilus* spp.)	6
Miscellaneous and undifferentiated	4
Anaerobic‡	***75***
Gram-positive cocci	30
Streptococcus spp.	33
Peptostreptococcus spp.	65
Gram-negative cocci (*Veillonella* spp.)	4
Gram-positive rods	14
Eubacterium spp.	
Lactobacillus spp.	
Actinomyces spp.	
Clostridia spp.	
Gram-negative rods	50
Bacteroides	75
Fusobacterium spp.	25
Miscellaneous	6

*In 404 patients.
†49 different species.
‡119 different species.

The anaerobic bacteria that cause infections include an even greater variety of species (see Table 15-2). Two main groups, however, predominate. The anaerobic gram-positive cocci account for about one third of the bacteria. These cocci are anaerobic *Streptococcus* and *Peptostreptococcus*. The gram-positive rods *Eubacterium* and *Lactobacillus* organisms are most commonly found in this group. The gram-negative anaerobic rods are cultured in about half of the infections. The *Prevotella* and *Porphyromonas* (previously *Bacteroides*) spp. account for about 75% of these, and *Fusobacterium* organisms account for 25%.

Of the anaerobic bacteria, several gram-positive cocci (i.e., anaerobic *Streptococcus* and *Peptostreptococcus* spp.) and gram-negative rods (i.e., *Prevotella* and *Fusobacterium* spp.) play a more important pathogenic role. The anaerobic gram-negative cocci and the anaerobic gram-positive rods appear to have little or no role in the cause of odontogenic infections; instead they appear to be opportunistic organisms.

The method by which mixed aerobic and anaerobic bacteria cause infections is known with some certainty. After initial inoculation into the deeper tissues, the more invasive organisms with higher virulence (i.e., the aerobic *Streptococcus* spp.) begin the infection process, initiating a cellulitis type of infection. The anaerobic bacteria will then also grow, and as the local reduction-oxidation potential is lowered (because of the growth of the aerobic bacteria), anaerobic bacteria become more prominent. As the infection reaches a more chronic, abscess stage, the anaerobic bacteria predominate and eventually become the exclusive causative organisms. Early infections appearing initially as a cellulitis may be characterized as *aerobic streptococcal infections,* and late, chronic abscesses may be characterized as *anaerobic infections.*

NATURAL HISTORY OF PROGRESSION OF ODONTOGENIC INFECTIONS

Odontogenic infections have two major origins: (1) periapical, as a result of pulpal necrosis and subsequent bacterial invasion into the periapical tissue, and (2) periodontal, as a result of a deep periodontal pocket that allows inoculation of bacteria into the underlying soft tissues. Of these two, the periapical origin is the most common in odontogenic infections.

Necrosis of the dental pulp as a result of deep caries allows a pathway for bacteria to enter the periapical tissues. Once this tissue has become inoculated with bacteria and an active infection is established, the infection will spread equally in all directions but preferentially along the lines of least resistance. The infection will spread through the cancellous bone until it encounters a cortical plate. If this cortical plate is thin, the infection erodes through the bone and enters the soft tissues. Treatment of the necrotic pulp by standard endodontic therapy or extraction of the tooth will resolve the infection. Antibiotics alone may stop the infection, but the infection is likely to recur when antibiotic therapy is ended and the tooth is not treated.

When the infection erodes through the cortical plate of the alveolar process, it appears in predictable anatomic locations. The location of the infection from a specific tooth is determined by the following two major factors: (1) the thickness of the bone overlying the apex of the tooth and (2) the relationship of the site of perforation of bone to muscle attachments of the maxilla and mandible.

Fig. 15-1 demonstrates how infections perforate through bone into the overlying soft tissue. In Fig. 15-1, *A,* the labial bone overlying the apex of the tooth is thin compared with the bone on the palatal aspect of the tooth. Therefore as the infectious process spreads it goes into the labial soft tissues. In Fig. 15-1, *B,* the tooth is severely flared, which results in thicker labial bone and a relatively thinner palatal bone. In this situation as the infection spreads through the bone into the soft tissue, the infection is expressed as a palatal abscess.

Once the infection has eroded through the bone, the precise location of the soft tissue infection will be determined by the position of the perforation relative to the muscle attachments. In Fig. 15-2, *A,* the infection has eroded through to the labial aspect of the tooth and infe-

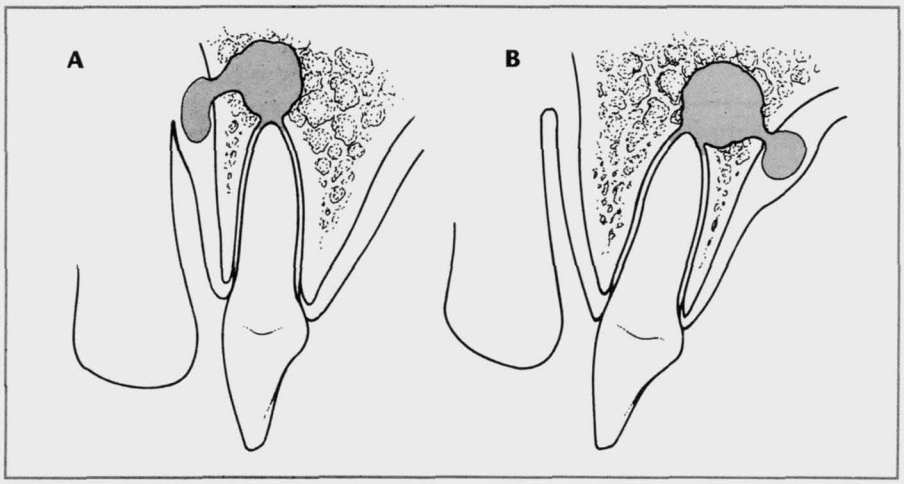

FIG. 15-1 When infection erodes through bone, it will enter soft tissue through thinnest bone. **A,** Tooth apex is near thin labial bone, so infection erodes labially. **B,** Right apex is near palatal aspect, so bone will be perforated.

rior to the attachment of the buccinator muscle, which results in an infection that appears as a vestibular abscess. In Fig. 15-2, *B*, the infection has eroded through the bone superior to the attachment of the buccinator muscle and will be expressed as an infection of the buccal space.

Infections from most maxillary teeth erode through the labiobuccocortical plate. They also erode through the bone below the attachment of the muscles that attach to the maxilla, which means that most maxillary dental abscesses appear initially as vestibular abscesses. Occasionally, a palatal abscess from a severely inclined lateral incisor or palatal root of a maxillary first molar will occur. Likewise, on occasion a long maxillary canine tooth will erode through the bone superior to the insertion of the levator anguli oris and will cause a canine space infection. More commonly, the maxillary molars will have infections that erode through the bone superior to the insertion of the buccinator muscle, which result in a buccal space infection.

In the mandible, infections of the incisors, canines, and premolars usually erode through the labiobuccocortical plate and above the associated musculature, resulting in vestibular abscesses. Molar teeth infections erode through the linguocortical bone more frequently than the anterior teeth. First-molar infections will drain either buccally or lingually. The second molar can perforate either buccally or lingually (but usually lingually), and third molar infections almost always erode through the linguocortical plate. The mylohyoid muscle will determine whether infections that drain lingually go into the sublingual or submandibular space.

The most common odontogenic infection is a vestibular abscess (Fig. 15-3). Occasionally, patients do not seek treatment for these infections, and the process will rupture spontaneously and drain, resulting in resolution of the infection. The infection will recur if the site of spontaneous drainage closes. Sometimes the abscess establishes a chronic sinus tract that drains to the oral cavity (Fig. 15-4). As long as the sinus tract continues to drain, the patient will experience no pain. Antibiotic administration will usually cause a cessation of the drainage, but when antibiotics are stopped, the drainage will recur. Definitive treatment of a chronic sinus tract requires treatment of the original problem, that is, the necrotic pulp treated by endodontic therapy or by extraction of the tooth.

PRINCIPLES OF THERAPY OF ODONTOGENIC INFECTIONS

This section discusses the management of the odontogenic infection. A series of principles are discussed that are useful in treating patients who come to the dentist with infections related to the teeth and gingiva. The clinician must keep in mind the information in the preceding two sections of this chapter to understand these principles.

Principle I: Determine Severity of Infection

Most odontogenic infections are mild and require only minor therapy. When the patient comes for treatment, the initial goal is to assess the severity of the infection. This determination is based on a complete history of the current infectious illness and a physical examination.

Complete history. The history of the patient's infection follows the same general guidelines as any history. The initial purpose is to find out the patient's chief complaint. Typical chief complaints of patients with infections are, "I have a toothache," "My jaw is swollen," or "I have a gum boil in my mouth." The complaint should be recorded in the patient's own words.

The next step in taking of the history is determining how long the infection has been present. First, the dentist should inquire as to time of *onset* of the infection. How long ago did the patient first have symptoms of pain, swelling, or drainage, which indicated the beginning of the infection? The *duration* of the infection is then discussed. Have the symptoms of the infection been constant, have they waxed and waned, or has the patient

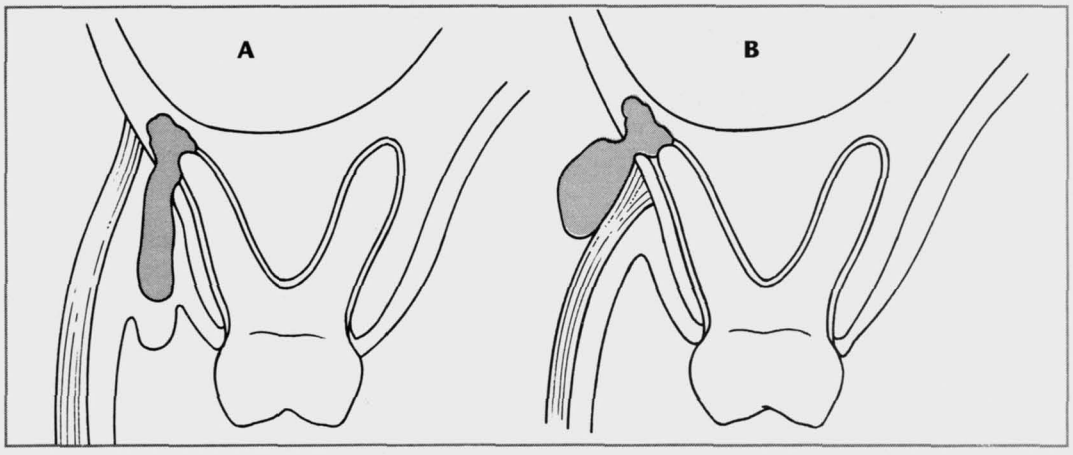

FIG. 15-2 Relationship of point of bone perforation to muscle attachment will determine fascial space involved. **A,** When tooth apex is lower than muscle attachment, vestibular abscess results. **B,** If apex is higher than muscle attachment, adjacent fascial space will be involved.

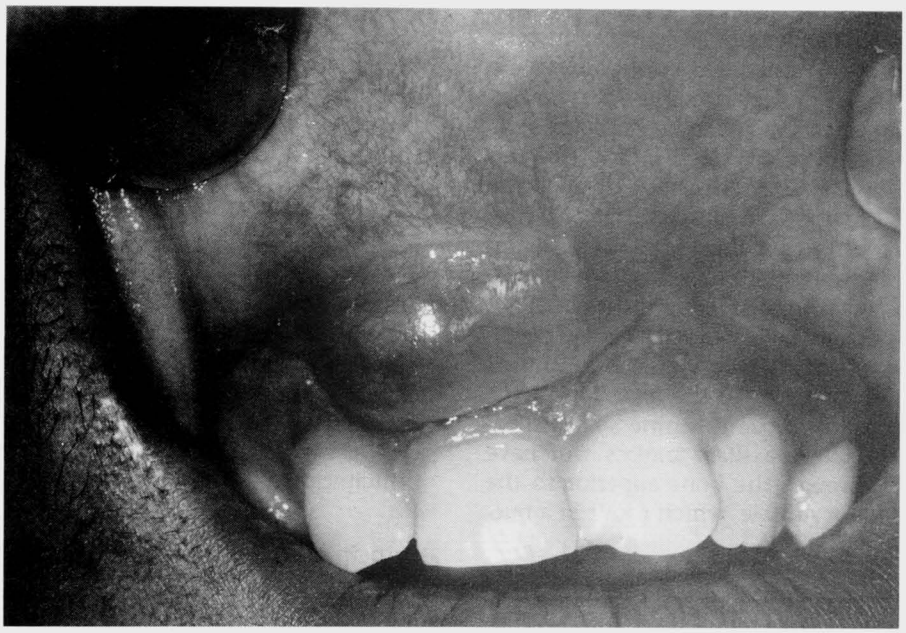

FIG. 15-3 Vestibular abscess arising from maxillary incisor. Overlying mucosa is thin because pus is near surface.

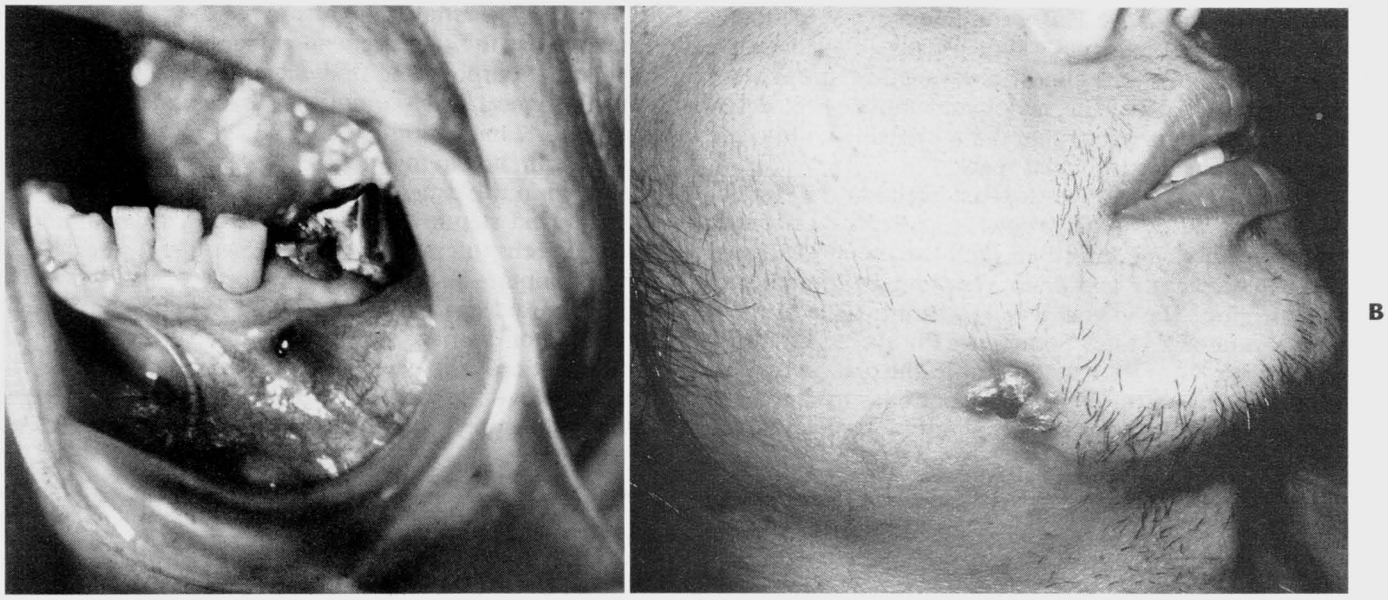

FIG. 15-4 Chronic drainage sinus tracts that result from low-grade infections may drain intraorally (**A**) or extraorally (**B**).

steadily grown worse since the symptoms were first noted? Finally, the practitioner should determine the *rapidity* of progress of the infection. Has the infection process progressed rapidly over a few hours, or has it gradually increased in severity over several days to a week?

The next step is eliciting the patient's symptoms. Infections are actually a severe inflammatory response, and the typical signs of inflammation are clinically easily discernible. These signs and symptoms are dolor (i.e., pain), tumor (i.e., swelling), calor (i.e., warmth), rubor (i.e., erythema, or redness), and functio laesa (i.e., loss of function.)

The most common complaint is dolor. The patient should be asked where the pain actually started and how the pain has spread since it was first noted; the second sign is tumor. Swelling is a physical finding that is sometimes subtle and not obvious to the practitioner, although it is to the patient. It is important that the dentist ask the patient to describe any area of swelling, where it is, and how large it feels. The third characteristic of infection is calor. The patient should be asked if the area feels hot. Rubor of the overlying area is the next characteristic to be discussed. The patient should be asked if there has been or currently is any change in color, espe-

cially redness, over the area of the infection. Functio laesa should then be checked. When inquiring about this characteristic, the dentist should ask about trismus and difficulty in swallowing, breathing, or chewing.

Finally, the dentist should ask how the patient feels in general. Patients who feel fatigued, hot, sick, and generally out of sorts are said to have *malaise.* Malaise usually indicates a generalized reaction to a moderate-to-severe infection (Fig. 15-5).

In the next step the dentist inquires about treatment. The dentist should ask about previous professional treatment and self-treatment. Many patients will "doctor" themselves with leftover antibiotics, hot soaks, and a variety of other home remedies. Occasionally, a dentist sees a patient who received treatment in an emergency room 2 or 3 days earlier and was referred to a dentist by the emergency room physician. The patient may have neglected to follow that advice until the infection became rather severe.

The patient's medical history should be obtained in the usual manner by interview or by self-administered questionnaire.

Physical examination. The first step in the physical examination is to collect the patient's vital signs. This includes temperature, blood pressure, pulse rate, and respiratory rate. The need for evaluation of temperature is obvious. Patients who have systemic involvement of infection will have elevated temperatures. Patients with severe infections will have temperatures elevated to 101° to 102° F (38.3° to 38.8° C).

The patient's pulse rate will increase as the patient's temperature increases. Pulse rates of up to 100 beats per minute are not uncommon in patients with infections. If pulse rates increase above 100 beats per minute, the patient may have a severe infection and should be treated more aggressively.

The vital sign that varies the least with infection is the patient's blood pressure. Only if the patient has significant pain and anxiety will there be a mild elevation in systolic blood pressure.

Finally, the patient's respiratory rate should be closely observed. One of the major considerations in odontogenic infections is the potential for upper airway obstruction as a result of extension of the infection into fascial spaces in the area of the pharynx. As respirations are monitored, the dentist should carefully check to ensure that the upper airway is clear and that breathing is without difficulty. The normal respiratory rate is 14 to 16 breaths per minute. Patients with mild-to-moderate infections have elevated respiratory rates of up to 18 to 20 breaths per minute.

Patients who have normal vital signs with only a mild temperature elevation usually have a mild infection that can be readily treated. Patients who have abnormal vital signs with elevation of temperature, pulse rate, and respiratory rate are more likely to have serious infection and require more elaborate therapy.

Once vital signs have been taken, attention should be turned to physical examination of the patient. The initial portion of the physical examination should be inspection of the patient's general appearance. Patients who have more than a minor, localized infection have an appearance of fatigue, feverishness, and malaise. This is a "toxic appearance" (see Fig. 15-5).

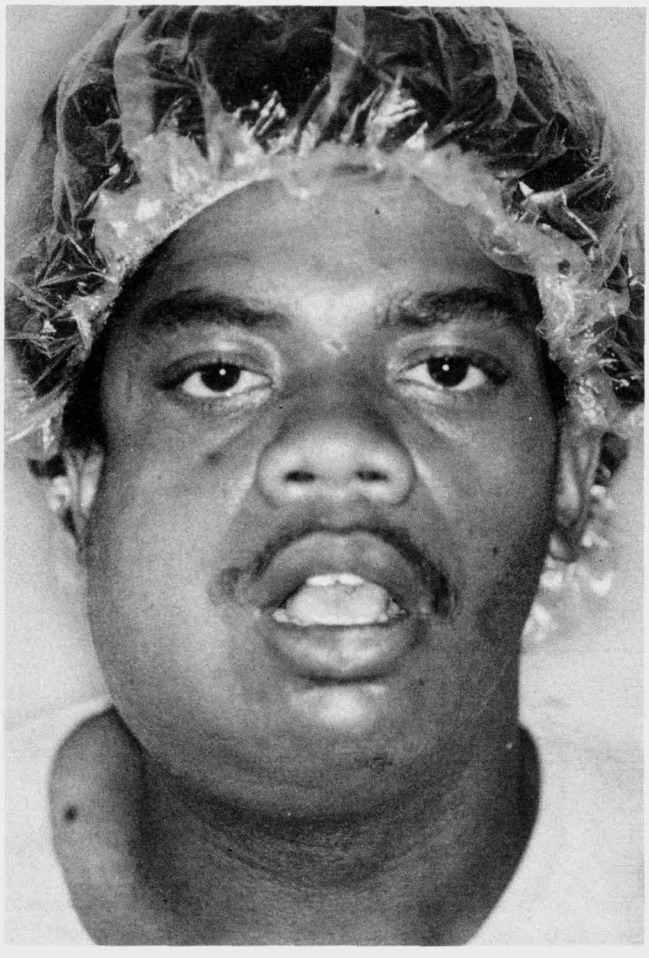

FIG. 15-5 Patient with severe infection and elevated temperature, pulse rate, and respiratory rate. The patient feels sick and tired; he has a "toxic appearance."

The patient's head and neck should be carefully examined for signs of infection and the patient inspected for any evidence of swelling and overlying erythema. The patient should be asked to open the mouth widely, swallow, and take deep breaths so that the dentist can check for dysfunction.

Areas of swelling must be examined by palpation. The dentist should gently touch the area of swelling to check for tenderness, amount of local warmth or heat, and the character of the swelling. The character of the swelling varies from feeling very soft and almost normal through a firmer swelling (described as having a *doughy feeling*) to an even firmer or hard swelling (described as feeling *indurated*). An indurated swelling has the same firmness as a tightened muscle. Another characteristic swelling texture is *fluctuant.* Fluctuance is the feeling of a fluid-filled balloon. Fluctuant swelling almost always indicates an accumulation of pus in the underlying tissues.

The dentist then performs an intraoral examination to try to find the specific cause of the infection. There may be severely carious teeth, an obvious periodontal abscess,

FIG. 15-6 Cellulitis infection involving submandibular region. It is indurated on palpation, and patient is quite sick.

severe periodontal disease, or combinations of caries and periodontal disease. The dentist should look and feel for areas of gingival swelling and fluctuance and for localized vestibular abscesses or draining sinus tracts.

The next step is to perform a radiographic examination. This usually consists of the indicated periapical radiographs; Occasionally, however, extraoral radiographs, such as a pantogram, may be necessary because of limited mouth opening or other extenuating circumstances.

After the physical examination, the practitioner should begin to have a sense of whether this particular patient has a *cellulitis* (Fig. 15-6) or an *abscess* (Fig. 15-7). These two terms describe two separate states of infection, which have distinct, unique methods of treatment.

Distinctions between the cellulitis and abscess are typically in duration, pain, size, peripheral definition, texture to palpation, presence of pus, and potential danger (Table 15-3). The duration of cellulitis is usually thought to be acute and is the initial presentation of the infection. An abscess, on the other hand, is usually a chronic process. Cellulitis is usually described as more painful than an abscess, which may be the result of its acute onset and distension of tissues.

The size of the cellulitic area is typically larger and more widespread than that of the abscess. The periphery

TABLE 15-3

General Differences Between Cellulitis and Abscess

Characteristic	Cellulitis	Abscess
Duration	Acute	Chronic
Pain	Severe and generalized	Localized
Size	Large	Small
Localization	Diffuse borders	Well circumscribed
Palpation	Doughy to indurated	Fluctuant
Presence of pus	No	Yes
Degree of seriousness	Greater	Less
Bacteria	Aerobic	Anaerobic

of a cellulitis is usually vague and indistinct, with a diffuse border that makes it difficult to determine where the swelling begins or ends. The abscess usually has distinct and well-defined borders. Texture to palpation is one of the primary distinctions between cellulitis and an abscess. When palpated, an early cellulitis can be very soft or doughy; a severe cellulitis is almost always described as indurated or even as being "boardlike." The severity of the cellulitis increases as its firmness to palpation increases. On palpation the abscess feels fluctuant, because it is a pus-filled cavity in the tissue. Finally, a cellulitis may be innocuous in its early stages and extremely dangerous in its more advanced, indurated, rapidly spreading stages. An abscess is typically less dangerous, because it is more chronic and less aggressive.

The presence of pus usually indicates that the body has walled off the infection and that the local host resistance mechanisms are bringing the infection under control. In many clinical situations the distinction between severe cellulitis and abscess may be difficult to make, especially if an abscess lies deeply within the soft tissue. In some patients an indurated cellulitis may have areas of abscess formation in it (see Chapter 16).

In summary, a cellulitis is an acute, painful infection with more swelling and diffuse borders. It can have a soft-to-hard texture on palpation and contains no pus. It may be a rapidly spreading process in serious infections. An abscess is a chronic infection with more localized pain, with less swelling and with well-circumscribed borders. It is fluctuant on palpation, because it is a pus-filled tissue cavity. A chronic abscess is usually slow growing and less serious than a cellulitis.

Principle II: Evaluate State of Patient's Host Defense Mechanisms

Part of the evaluation of the patient's medical history is designed to establish the patient's ability to defend against infection. Several disease states and several types of drug use may compromise this ability. Compromised

FIG. 15-7 Well-localized abscess has crusted surface secondary to tissue necrosis. Mass is fluctuant on palpation.

patients are more likely to have infections, and these infections often become serious more rapidly. Therefore to manage their infections more effectively, it is important to be able to discern those patients who may have a compromised host defense mechanism.

Medical conditions that compromise host defenses. It is important to delineate those medical conditions that may result in decreased host defenses. These compromises allow more bacteria to enter the tissues or to be more active, or they prevent the humoral or cellular defenses from exerting their full effect. Several specific conditions may compromise patients' defenses (Box 15-1).

Severe, uncontrolled metabolic diseases, such as severe diabetes, end-stage renal disease that leads to uremia, and severe alcoholism with malnutrition, result in decreased function of leukocytes, including decreased chemotaxis, phagocytosis, and bacterial killing.

The second major group of host compromisers is diseases that interfere with host defense mechanisms, such as leukemias, lymphomas, and many types of cancer. These result in decreased white cell function and decreased antibody synthesis and production.

Patients taking certain drugs are also compromised. Cancer chemotherapeutic agents decrease circulating white cell counts to extremely low levels, commonly below 1000 cells per milliliter. When this occurs patients will be unable to defend themselves effectively against bacterial invasion. Patients on immunosuppressive therapy, usually for organ transplantation or autoimmune diseases, are compromised. The common drugs in these categories are cyclosporin, corticosteroids, and azathioprine (Imuran). These drugs decrease T- and B-lymphocyte function and immunoglobulin production.Thus patients taking these medications are more likely to have severe infections.

BOX 15-1

Compromised Host Defenses

Uncontrolled metabolic diseases:
- Uremia
- Alcoholism
- Malnutrition
- Severe diabetes

Suppressing diseases:
- Leukemia
- Lymphoma
- Malignant tumors

Suppressing drugs:
- Cancer chemotherapeutic agents
- Immunosuppressive agents

In summary, when evaluating a patient whose chief complaint may be an infection, the patient's medical history should be carefully examined for the presence of diabetes, severe renal disease, alcoholism with malnutrition, leukemias and lymphomas, cancer chemotherapy, and immunosuppressive therapy of any kind. When the patient's history includes any of these, the patient with an infection must be treated much more vigorously, as the infection may spread more rapidly. Early and aggressive surgery to remove the cause and more intense parenteral antibiotic therapy must be considered.

Additionally, when a patient with a history of one of these problems is seen for routine oral surgical procedures, it may be necessary to provide the patient with prophylactic antibiotics to attempt to prevent an infection from occurring.

BOX 15-2

Criteria for Referral to a Specialist

- Rapid progressive infection
- Difficulty in breathing
- Difficulty in swallowing
- Fascial space involvement
- Elevated temperature (greater than 101° F)
- Severe jaw trismus (less than 10 mm)
- Toxic appearance
- Compromised host defenses

Principle III: Determine Whether Patient Should Be Treated by General Dentist or Specialist

Most odontogenic infections seen by the dentist can be managed with the expectation of normal rapid resolution. Odontogenic infections, when treated with minor surgical procedures and commonly used antibiotics, almost always respond rapidly. However, some odontogenic infections are potentially life threatening and require aggressive medical and surgical management. In these special situations, early recognition of the potential severity is essential and these patients should be referred to a specialist, usually an oral-maxillofacial surgeon, for definitive management. For some patients, hospitalization will be required, whereas others will be managed as outpatients.

When a patient with an odontogenic infection comes for treatment, the dentist must have a set of criteria by which to judge the seriousness of the infection (Box 15-2). If some or all of these criteria are met, immediate referral must be considered.

Three main criteria suggest immediate referral to a specialist. The first is a history of a *rapidly progressing infection.* This means that the infection began 1 or 2 days before the interview and is growing rapidly worse, with increasing swelling, pain, and associated signs and symptoms. This type of odontogenic infection may spread to areas in which it is potentially life threatening and therefore must be treated aggressively. The second criterion is *difficulty in breathing.* Patients who have severe swelling of the soft tissue of the upper airway as the result of infection may have difficulty maintaining a patent airway. In these situations the patient often cannot lie down, has difficulty with speech, and is obviously distressed with the breathing difficulties. This patient should be referred directly to an emergency room, because immediate surgical attention may be necessary to maintain an intact airway. The third urgent criterion is *difficulty in swallowing.* Patients who have swelling and trismus may have difficulty swallowing their saliva. This is an ominous sign, because difficulty in swallowing frequently indicates a narrowing of the oral pharynx and potential for acute airway embarrassment. This patient should also be referred to the hospital emergency room, because surgical intervention may be required for airway maintenance.

Several other criteria should indicate referral to the specialist. Patients who have involvement of extraoral fascial spaces, such as buccal space infections or submandibular space infections, may require extraoral surgical incision and drainage (I&D), as well as hospitalization. Next, although infection almost always causes an elevated temperature, a temperature higher than 101° F indicates a greater likelihood of severe infection and the patient should be referred. Another important sign is trismus, which is the inability to open the mouth widely. In odontogenic infections, trismus results from the involvement of the muscles of mastication in the inflammatory process. A patient with mild-to-moderate trismus will be able to open the mouth up to 15 mm.

Severe trismus—the inability to open the mouth wider than 10 mm—may be an indication of severe oral pharyngeal involvement of the infection. In this situation referral to a specialist is necessary for evaluation of upper airway patency. In addition, systemic involvement of an odontogenic infection is an indication for referral. Patients with systemic involvement will have a typical toxic facial appearance: glazed eyes, open mouth, and a dehydrated, sick appearance. When this is seen, the patient is usually fatigued, has a substantial amount of pain, has an elevated temperature, and is dehydrated. Finally, if the patient has readily identifiable host defenses, hospitalization is likely to be required. A specialist is usually prepared to admit the patient expeditiously.

Principle IV: Treat Infection Surgically

The primary principle of management of odontogenic infections is to perform surgical drainage and removal of the cause of the infection. Surgical treatment may range from something as simple as the opening of a tooth and extirpation of the necrotic tooth pulp to treatment as complex as the wide incision of soft tissue in the submandibular and neck regions for a severe infection.

The primary goal in surgical management of infection is to remove the cause of the infection, which is most commonly a necrotic pulp or deep periodontal pocket. A secondary goal is to provide drainage of accumulated pus and necrotic debris.

When a patient has a typical odontogenic infection, the most likely appearance will be a small vestibular abscess. With this presentation the dentist has the three options for surgical management of endodontic treatment, extraction, or I&D. If the tooth is not to be extracted, it should be opened and the pulp removed, which results in elimination of the cause and obtaining limited drainage. If the tooth cannot be salvaged, it should be extracted as soon as possible.

Extraction provides both removal of the cause of the infection and drainage of the accumulated pus and debris. In addition to the endodontic procedure or extraction of the tooth, an I&D procedure may be required. Incision of the abscess cavity provides for drainage of the accumulated pus and bacteria from the underlying tissue. Drainage of pus provides for a reduction in tissue tension, which improves the local blood supply and increases the delivery of host defenses to the localized area. The I&D procedure includes the insertion of a drain to prevent the closure of the mucosal incision, which would result in

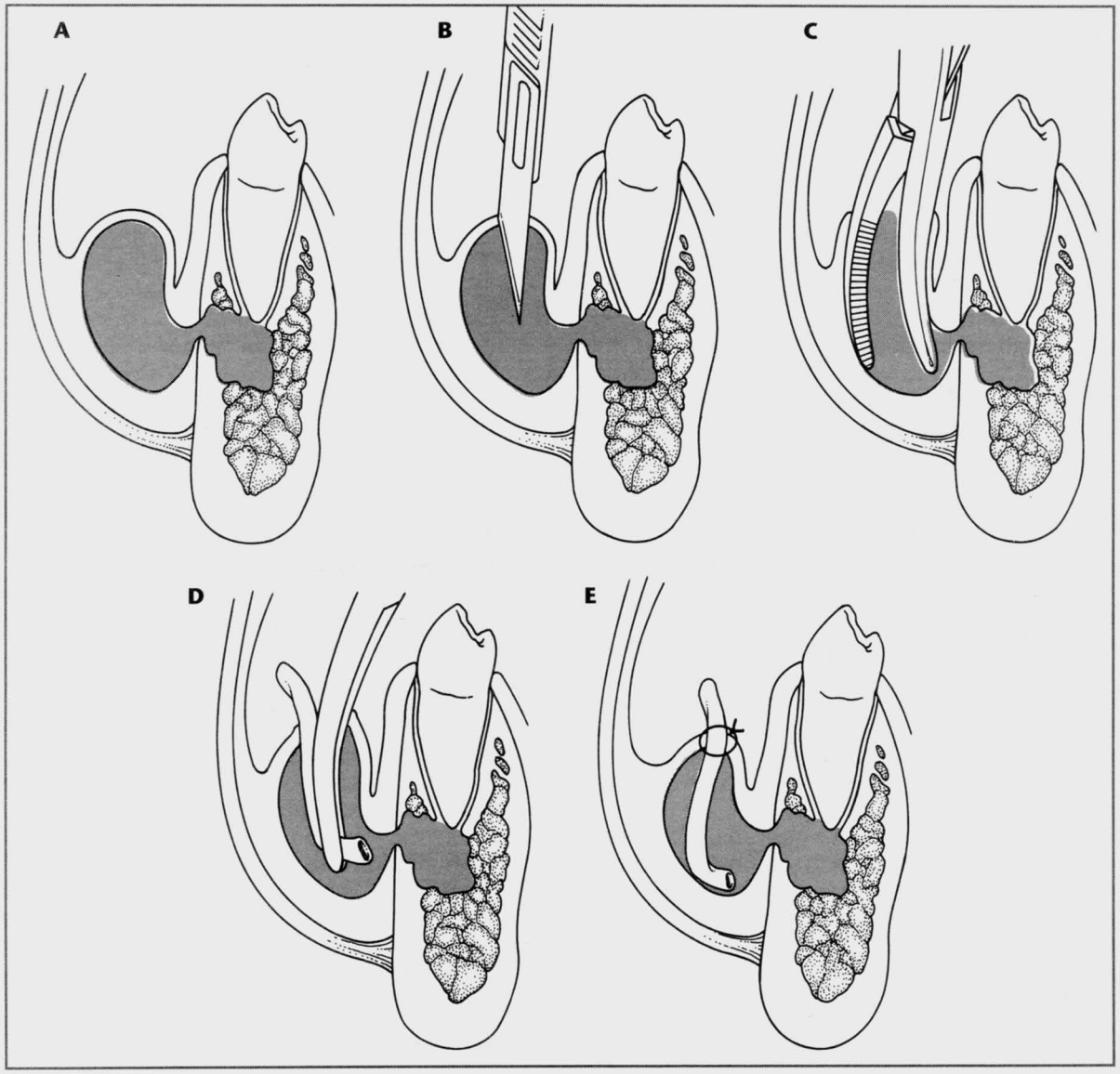

FIG. 15-8 **A,** Periapical infection of lower premolar extends through buccal plate and creates sizable vestibular abscess. **B,** Abscess is incised with no. 11 blade. **C,** Beaks of hemostat are inserted through incision and opened so that beaks spread to break up any loculations of pus that may exist in abscessed tissue. **D,** Small drain is inserted to depths of abscess cavity with hemostat. **E,** Drain is sutured into place with single black silk suture.

reformation of the abscess cavity. It is important to remember that the surgical goal is to achieve adequate drainage. If endodontic opening of the tooth does not provide adequate drainage of the abscess, it is essential to perform an I&D.

The technique for I&D of a fluctuant vestibular abscess is straightforward (Fig. 15-8). The preferred site for the incision is directly over the most dependent area, to encourage drainage. (When I&D procedures are performed extraorally, a more complex set of criteria must be met when selecting a site for the incision.) Once the area of incision has been selected, a method of pain control must be used. Regional nerve block anesthesia achieved by injecting an area away from the site of the incision is preferred. Alternatively, superficial infiltration of local anesthetic solution anterior and posterior to the area to be drained can be used.

Before the actual incision of the abscess cavity is performed, consideration must be given to obtaining a specimen of the pus for culture and sensitivity (C&S) testing. If the decision is made to perform a culture, the procedure is carried out as the initial portion of the surgery. Once the localized area has been anesthetized, a large-gauge needle, usually 18 gauge, is used for specimen collection. A small syringe, usually 2 mL, is adequate. The surface mucosa is disinfected with a solution such as Betadine and dried with sterile gauze. The needle is then inserted into the abscess cavity, and 1 or 2 mL of pus is aspirated. The syringe is held vertically, and any air bubbles contained in the syringe are ejected from it. The tip of the

needle is then capped with a rubber stopper and taken directly to the microbiology laboratory. This method for obtaining a specimen permits both aerobic and anaerobic cultures and Gram's staining. As discussed earlier, anaerobic bacteria are almost always present in odontogenic infections, and therefore care must be taken to provide the laboratory the best opportunity to find them.

Once the culture specimen is obtained, an incision is made with a no. 11 blade just through the mucosa and submucosa into the abscess cavity (see Fig. 15-8). The incision should be short, usually no more than 1 cm in length. Once the incision is completed, a closed curved hemostat is inserted through the incision into the abscess cavity. The hemostat is then opened in several directions to break up any small loculations or cavities of pus that have not been opened by the initial incision. The pus that drained out during this time should be aspirated into the suction and should not be allowed to drain into the patient's mouth.

Once all areas of the abscess cavity have been opened and all pus drained, a small drain is inserted to maintain the opening. The most commonly used drain for intraoral abscesses is a one-forth inch sterile Penrose drain. A frequently used substitute is a small strip of sterilized rubber dam. A piece of drain of adequate length to reach the depth of the abscess cavity is prepared and inserted into the cavity, using the hemostat. The drain is then sutured into place with a nonresorbable suture. The suture should be placed in viable tissue to prevent loss of the drain as the result of the suture tearing through nonvital tissue.

The drain should remain in place until all the drainage from the abscess cavity has stopped, usually 2 to 5 days. Removal is done by simply cutting the suture and slipping the drain from the wound.

Early-stage infections that initially appear as a cellulitis with soft, doughy, diffuse swelling do not typically respond to I&D procedures. Surgical management of infections of this type is limited to removal of the necrotic pulp or removal of the involved tooth.

It is critical to keep in mind that the *primary* method for treating odontogenic infections is to perform surgery to remove the source of the infection and drain pus where it exists. Whenever an abscess cavity with pus is diagnosed, the surgeon must drain it. Failure to do so will result in worsening of the infection and failure of the infection to resolve, even if antibiotics are given. If the surgeon questions whether pus is present, a test aspiration should be done with an 18-gauge needle. Even if the tooth can neither be opened nor extracted, incision of the abscess cavity to drain the pus should be done.

The algorithm presented in Fig. 15-9 represents the thought process that should be used in deciding on a surgical approach. First, the surgeon should decide if the patient has an abscess. If so, the tooth should be extracted and the abscess drained, either through the socket or a separate I&D. Then the patient should be given antibiotics. If the patient does not have an abscess but has mild cellulitis, the tooth should be extracted and the patient given antibiotics. If the cellulitis is severe, extraction *and* I&D should be performed.

Antibiotics are also given. For the severe cellulitis, the dentist should consider referral to an oral and maxillofacial surgeon.

Principle V: Support Patient Medically

Patients with odontogenic infections may have depressed host defense mechanisms as the result of the pain and swelling associated with the infection. Because of the pain from the infection, patients frequently have not had adequate fluid intake, nutritional intake, or rest. During the immediate post-I&D period, patients should be encouraged to drink a lot of water or juice and take high-calorie nutritional supplements. They should also be prescribed adequate analgesics for relief of pain so that they can rest. Patients should be given careful postoperative instructions and should be able to manage this portion of their therapy without complications. It is the

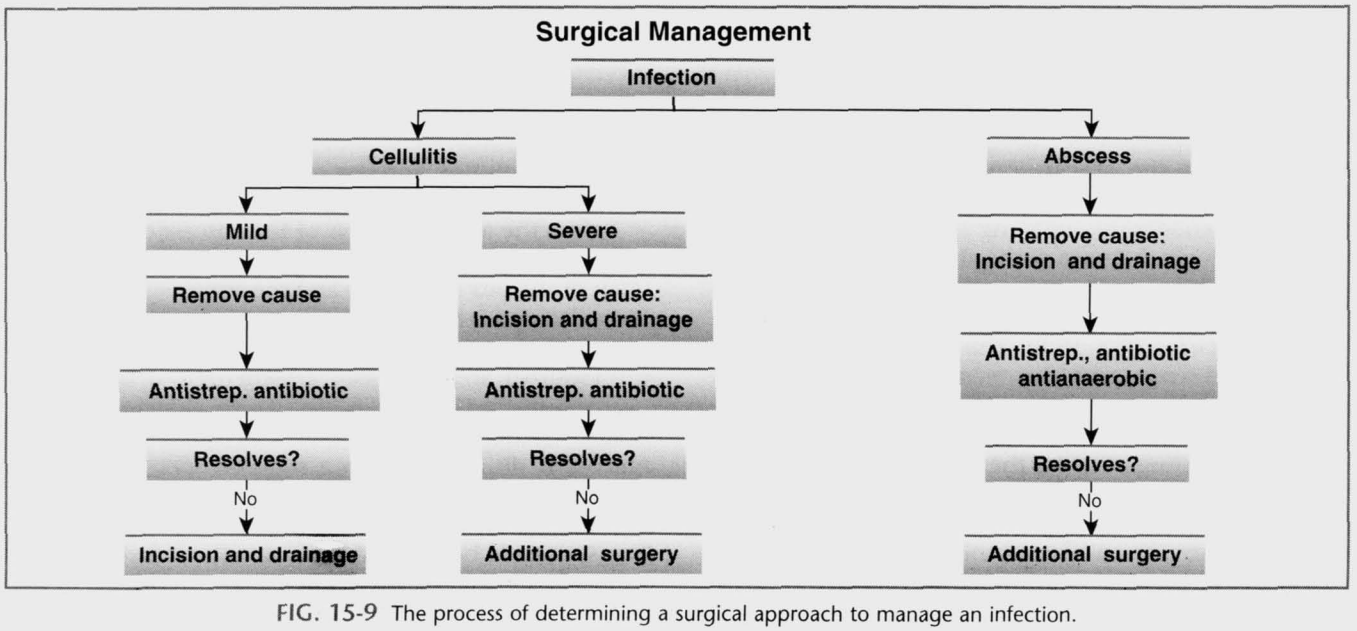

FIG. 15-9 The process of determining a surgical approach to manage an infection.

responsibility of the clinician, however, to provide careful instructions about these important issues.

Principle VI: Choose and Prescribe Appropriate Antibiotic

Choosing the appropriate antibiotic for treating an odontogenic infection must be done carefully. When all factors are weighed, the clinician may decide that no antibiotic is necessary at all, whereas in other situations, broad-spectrum or even combination antibiotic therapy may be necessary. A variety of factors must be considered when choosing an antibiotic from the nearly 70 antibiotics currently available. Antibiotics must be viewed as a double-edged sword. Although appropriate use may result in dramatic resolution and cure of patients with infections, misuse of antibiotics provides little benefit to offset the associated risks and expense of antibiotic administration. Therefore the following guidelines are recommended for consideration when choosing a specific antibiotic.

Determine need for antibiotic administration. It is a common misconception that all infections, by definition, require antibiotic administration; this is not necessarily the case. In some situations antibiotics are not useful and, in fact, may be contraindicated. In making this determination, three factors must be considered: The first factor is the seriousness of the infection when the patient comes to the dentist. If the infection has modest swelling, has progressed rapidly, or is a diffuse cellulitis, the evidence would support the use of antibiotics in addition to surgical therapy. The second factor is whether adequate surgical treatment can be achieved. In many situations extraction of the offending tooth may result in rapid resolution of the infection. However, in other situations, removal of the tooth may not be possible. Antibiotic therapy is important to control the infection so that the tooth can be removed. The third consideration is the state of the patient's host defenses. A young, healthy patient may be able to mobilize host defenses and need less antibiotic therapy for resolution of the infection. On the other hand, patients who have any type of decreased host resistance, such as those with severe metabolic disease or those receiving cancer chemotherapy, may require vigorous antibiotic therapy for even minor infections.

When these three factors are balanced, several definite indications for antibiotic use in dentistry become clear (Box 15-3). The first and most common indication is the presence of an acute-onset infection with diffuse swelling and moderate-to-severe pain. This infection is usually in the cellulitis stage, and, with appropriate antibiotic therapy and treatment of the offending tooth, rapid resolution is expected. The second indication is almost any type of infection in a patient who is medically compromised. Such patients who have infections of any severity should be considered candidates for antibiotic administration. The third indication for antibiotic therapy is the presence of an infection that has progressed to involvement of extraoral fascial spaces. In these situations the infection is aggressive enough to have spread beyond the mouth, indicating that the host defenses are inadequate to contain the infection. The fourth indication is severe pericoronitis, with temperatures higher than 100° F, trismus, and some swelling of the lateral aspect of the face, which occurs most commonly around impacted mandibular third molars. Finally, the patient who has osteomyelitis requires antibiotic therapy in addition to surgical therapy to achieve resolution of the infection.

Based on the same three criteria, antibiotic therapy would not be indicated or is even contraindicated in other situations (Box 15-4). The first is a minor, chronic, well-localized abscess for which an I&D and treatment of the offending tooth result in rapid resolution, assuming that the patient's host defenses are intact and that the patient has no other compromising conditions. A second, albeit similar, contraindication is a very well-localized vestibular abscess, with little or no facial swelling. In these situations the tooth can be opened and necrotic pulp removed or the tooth extracted and the abscess incised and drained, which will result in rapid resolution in most patients. Third is a localized alveolar osteitis, or dry socket. Treatment of the dry socket is primarily palliative, and it is not treated as an infection. Fourth, patients who have mild pericoronitis with minor gingival edema and mild pain do not require antibiotics for resolution of their infection. Irrigation with hydrogen peroxide or chlorhexidine will result in resolution.

In summary, antibiotics should be used when clear evidence exists of bacterial invasion into underlying tissues that is greater than the host defenses can withstand. Patients who have an impaired ability to defend themselves against infection and patients who have infections that are not amenable to surgical treatment should be considered for antibiotic therapy. Antibiotics should not be used when no evidence of bacterial involvement is found. Antibiotics do not hasten wound healing and do not provide any benefit for nonbacterial conditions. Patients who have inflammatory pulpitis will have severe

BOX 15-3

Indications for Use of Antibiotics

- Rapidly progressive swelling
- Diffuse swelling
- Compromised host defenses
- Involvement of fascial spaces
- Severe pericoronitis
- Osteomyelitis

BOX 15-4

Situations in Which Use of Antibiotics Is Not Necessary

- Chronic well-localized abscess
- Minor vestibular abscess
- Dry socket
- Mild pericoronitis

pain, but the pain results from local inflammatory reaction within the pulp, not from bacterial infection. These patients should not be given antibiotic therapy.

Use empirical therapy routinely. Odontogenic infections are caused by a highly predictable group of bacteria. Additionally, the antibiotic sensitivity of these organisms is well known and consistent. As a result the use of C&S testing is not necessary for routine odontogenic infections. The bacteria that cause more than 90% of odontogenic infections are aerobic streptococci and anaerobic streptococci, peptostreptococci, *Prevotella,* and *Fusobacterium.* Many other species of bacteria are also involved, but they appear to be opportunistic rather than causative bacteria. Fortunately the antibiotic susceptibility of the causative bacteria is remarkably consistent. The orally administered antibiotics that are effective against odontogenic infections include penicillin, amoxicillin, clarithromycin, clindamycin, cefadroxil, metronidazole, and doxycycline (Box 15-5).

These antibiotics are effective against streptococci (except metronidazole) and oral anaerobes. Several relatively important variations can be found within the group. (See Appendix IX for detailed description of the various antibiotics.)

Because the microbiology and antibiotic sensitivity is well known, it is a reasonable therapeutic maneuver to use one of these antibiotics empirically, that is, to give the antibiotic with the assumption that an appropriate drug is being given. The drug of choice is usually penicillin. Alternative drugs for use in the penicillin-allergic patient are clarithromycin and clindamycin. The cephalosporin cefadroxil is a useful drug when a broader antibacterial spectrum is necessary. The cephalosporins should be used with caution in penicillin-allergic patients, because they may also be allergic to the cephalosporins. Doxycycline is another useful alternative, although some strains of bacteria are resistant to the tetracyclines. Metronidazole is useful only against anaerobic bacteria and should be reserved for situations in which only anaerobic bacteria are suspected (or in combination with an antibiotic that has antiaerobic activity such as penicillin).

It is clear that patients often, if not usually, fail to take the medication in the way in which it was prescribed. In fact, Socrates in 400 BC cautioned physicians to be aware that patients will lie about taking the medications prescribed.

Hard data exist from many studies that demonstrate that patient compliance decreases with increasing number of pills per day. When it is necessary to take the prescription one time daily, patient compliance is approximately 80%. However, when it is necessary to take the pill two times daily, compliance decreases to 69% and drops even further to 35% for four times daily. Therefore if the clinician has a choice, antibiotics should be prescribed that can be given the fewest times daily to improve patient compliance.

For example, amoxicillin is usually given three times daily instead of four times daily (as is penicillin). Azithromycin is a twice a day medication instead of four times daily with erythromycin. Doxycycline is usually given once daily. Thus when other important factors are reasonably equal, a drug that can be given less frequently is preferable.

Routine C&S testing is not cost-effective for the routine odontogenic infection. However, in some cases the dentist should seriously consider sending a specimen for C&S testing (Box 15-6). The first is the rapid onset of infection and its rapid spread. Delay in bacterial identification may have disastrous consequences in this situation. The second case is postoperative infection. If a patient had no signs of infection when the original surgery was done but returns 3 or 4 days later with an infection, the probability of nonindigenous bacteria causing the infection is higher. Precise identification of the causative bacteria may be critical to facilitate resolution of the infection. The third case is an infection that is not resolving. In these situations the clinician should make every effort to obtain a specimen of pus for culture and antibiotic sensitivity testing. The fourth case is a recurrent infection. When the initial infectious problem has resolved and there has been an infection-free period of 2 days to 2 weeks but a second infection occurs, the probability is high that the infection is caused by bacteria that have altered antibiotic sensitivity patterns. The fifth case is the patient who has compromised host defenses.

The causative bacteria are not likely to be different from the usual odontogenic infection; however, because these patients have a decreased ability to defend themselves from infection, it is advantageous to have a precise diagnosis of the causative organisms for maximal effectiveness.

Use narrowest spectrum antibiotic. When an antibiotic is administered to a patient, all susceptible bacteria are killed. If the antibiotic is a narrow-spectrum antibiotic, it kills bacteria of a narrow range. For example,

BOX 15-5

Effective Orally Administered Antibiotics Useful for Odontogenic Infections

- Penicillin
- Erythromycin
- Clindamycin
- Cefadroxil
- Metronidazole
- Tetracycline

BOX 15-6

Indications for Culture and Antibiotic Sensitivity Testing

- Rapidly spreading infection
- Postoperative infection
- Nonresponsive infection
- Recurrent infection
- Compromised host defenses

penicillin will kill streptococci and oral anaerobic bacteria but will have little effect on the staphylococci of the skin and almost no effect on gastrointestinal tract bacteria. As a result, penicillin has little or no effect on the gastrointestinal tract and does not expose a multitude of other bacteria to the opportunity to develop resistance. By contrast, drugs such as tetracycline are broad-spectrum antibiotics, inhibiting not only the streptococci and oral anaerobes but also a variety of gram-negative rods. Thus when this antibiotic is given, it has an effect on skin and gastrointestinal bacteria that may result in problems caused by alterations of host flora and overgrowth of resistant bacteria. In addition, broad-spectrum antibiotics provide a multitude of bacteria the opportunity to develop resistance.

In summary, antibiotics that have narrow-spectrum activity against the causative organisms are just as effective as antibiotics that have broad-spectrum activity, without the problems of upsetting normal host microflora populations and increasing the chance of bacterial resistance.

Use antibiotic with lowest incidence of toxicity and side effects. Most antibiotics have a variety of toxicities and side effects that limit their usefulness. These range from mild to so severe that the antibiotic cannot be used in clinical practice. The antibiotics usually used for odontogenic infections have a surprisingly low incidence of toxicity-related problems. It is important, however, for the clinician to understand the probable toxicities and side effects of the drugs they use.

Allergy is penicillin's major side effect. Approximately 2% or 3% of the total population is allergic to penicillin. Patients who have allergic reactions to penicillin, as exhibited by hives, itching, or wheezing, should not be given penicillin again. Penicillin does not have other major side effects or toxicities in the normal dose range used by dentists.

Likewise, clarithromycin, erythromycin, and clindamycin have a low incidence of toxicity and side effects. Clindamycin may cause a severe diarrhea state called *pseudomembranous colitis*. Several other drugs, such as ampicillin and the oral cephalosporins, also cause this problem. The elimination of much of the anaerobic gut flora allows the overgrowth of an antibiotic-resistant bacteria, *Clostridium difficile*. This bacteria produces toxins that injure the gut wall, which results in colitis. Patients who take clindamycin, amoxicillin, or cefadroxil should be warned of the possibility of profuse watery diarrhea and told to contact their prescribing dentist if it occurs.

The oral cephalosporins are associated with only mild toxicity problems. As with penicillin, the cephalosporins may cause allergic reactions. They should be given cautiously to patients with penicillin allergies, because these patients may be allergic to the cephalosporins also. Patients who have experienced an anaphylactic type of reaction to penicillin should *not* be given a cephalosporin because of increased chance for that life-threatening event to occur again.

The tetracyclines have minor toxicities for most patients (i.e., the commonly encountered gastrointestinal problems of nausea, abdominal cramping, and diarrhea). Some patients may develop a photosensitivity while they are taking this drug and should be warned to stay out of the sun. Finally, tetracyclines may produce tooth discoloration if given to patients who are pregnant or who are in the tooth development stages of their lives. This discoloration is the result of chelation of the tetracycline to calcium, which results in incorporation of the tetracycline into developing teeth.

Metronidazole has mild toxicities, the most prominent being the typical gastrointestinal disturbances discussed previously. The drug may also produce a disulfiram effect; that is, the patient taking metronidazole who also drinks ethanol may experience sudden violent abdominal cramping and vomiting.

Use bactericidal antibiotic, if possible. Antibiotics may either kill bacteria (i.e., bactericidal antibiotics) or interfere with reproduction (i.e., bacteriostatic antibiotics). Bactericidal antibiotics usually interfere with cell wall production of newly forming, growing bacteria. The resultant defective cell wall is not able to withstand osmotic pressure differential, and the bacteria literally explode. The antibiotic actually kills the bacteria, whereas host white cells complement and antibodies play a less important role in fighting the bacteria.

Bacteriostatic antibiotics interfere with bacterial reproduction and growth. This slowing of bacterial reproduction allows the host defenses to move into the area of infection, phagocytize the existing bacteria, and kill them. Bacteriostatic antibiotics require reasonably intact host defenses. This type of antibiotic should be avoided in patients who have compromised host defense systems.

For patients with compromised host defenses, bactericidal antibiotics should be the drug of choice. For example, the bactericidal antibiotic penicillin would be preferred over the bacteriostatic antibiotic erythromycin in a patient who is receiving cancer chemotherapy.

Be aware of the cost of antibiotics. Antibiotics vary widely in their cost to patients. Newer drugs tend to be more expensive, whereas older drugs, which are made by a variety of companies, tend to be less expensive. Drugs prescribed generically also tend to be less expensive than brand name prescriptions. Generic prescriptions for newer drugs are not available. When other factors are equal, the clinician should prescribe the less-expensive antibiotic.

Summary

Antibiotics should be used to assist the dentist in treating patients with infections. Surgical treatment of the infection remains the primary method of treatment in most patients; antibiotic therapy plays an adjunctive role. Antibiotics are especially important in patients who have infections that cannot be adequately treated by surgery alone (e.g., cellulitis) and in patients who have some compromise of their host defense mechanisms. When antibiotic therapy is to be used for a routine odontogenic infection, empirical antibiotic therapy is recommended, because the microbiology of odontogenic infections is well known and usually consistent from patient to patient. The antibiotic of choice for odontogenic infections is still penicillin. Penicillin is bactericidal; has a nar-

row spectrum that includes streptococci and the oral anaerobes, which are responsible for approximately 90% of odontogenic infections; has low toxicity; and is inexpensive.

Although many *Prevotella* are resistant to penicillin, when used in conjunction with adequate surgery, penicillin almost always results in cure. An alternative drug is clarithromycin, which is a useful medication for patients who are allergic to penicillin. Clindamycin is also a useful alternative, but its increased toxicity make it most useful in special situations in which resistant anaerobic bacteria are suspected. The oral cephalosporins are excellent choices when the patient has a history of mild allergy to penicillin and in whom bacteria other than the normal oral flora are suspected. Both cefadroxil and cephalexin are good choices, but cefadroxil is given twice daily instead of four times daily for cephalexin.

Tetracycline, especially doxycycline, is a good choice for mild infections. Metronidazole may be a useful adjunct when only anaerobic bacteria are involved. Although slightly more than one third of all odontogenic infections are caused by only anaerobic bacteria, this cannot be predicted reliably; therefore the use of metronidazole alone in acute infections should be somewhat limited.

Principle VII: Administer Antibiotic Properly

Once the decision is made to prescribe an antibiotic to the patient, the drug should be administered in the proper dose and at the proper dose interval. The manufacturer usually recommends the proper dose. It is adequate to provide plasma levels that are sufficiently high to kill the bacteria that are sensitive to the antibiotic but are not so high as to cause toxicity. The peak plasma level of the drug should usually be at least 4 or 5 times the minimal inhibitory concentration for the bacteria involved in the infection.

Likewise, the clinician must administer the antibiotic at the proper interval. This interval is usually recommended by the manufacturer and is determined by the plasma half-life of the drug. The interval is usually 4 times the plasma half-life of the drug. Strict adherence to this interval is critical with the bacteriostatic antibiotics but is much less important with bactericidal antibiotics, because bacteria exposed to bactericidal antibiotics will die from a defective cell wall, but those exposed to bacteriostatic antibiotics can resume protein synthesis once the antibiotic is gone.

It is clear that patients stop taking their antibiotics after acute symptoms have subsided and rarely take their drugs as prescribed after 5 or 6 days. Despite what the prescription says, patients rarely take antimicrobial agents as prescribed longer than 3 or 4 days. Therefore the antibiotic that would have the highest compliance would be the drug that could be given once a day for 4 or 5 days.

When antibiotics are given, they should be given for an adequate period. The traditional recommendation has been to continue antibiotic therapy for 2 to 3 days after the infection has resolved. In clinical terms this means that the patient, who has been treated with both surgery and antibiotics, will usually have dramatic improvement in symptoms by the second day, and by the fourth day will be reasonably asymptomatic.

Antibiotics should then be administered for an additional 2 days, for a total of 6 days. Most mild odontogenic infections that are treated on an outpatient basis can usually be managed with a prescription for antibiotics sufficient for 6 or 7 days.

In some situations no surgical therapy (i.e., no endodontics or extraction) is provided. In these situations, resolution of the infection will take longer. Therefore the prescription should be written for 9 or 10 days of antibiotics.

Additional administration of antibiotics may be necessary in some infections that do not resolve as rapidly. It is important for the clinician to make it clear to the patient that the entire prescription should be taken. If for some reason the patient is advised to stop taking the antibiotic early, all remaining pills or capsules should be discarded. Keeping small amounts of unused antibiotics in medicine cabinets for the anticipated sore throat next winter should be strongly discouraged. Casual self-administration of antibiotics is not useful and may be hazardous to the health of the individual and community.

Principle VIII: Evaluate Patient Frequently

Once the patient has been treated by surgery and antibiotic therapy has been prescribed, the patient should be followed up carefully to monitor response to treatment and complications. In most situations the patient should be asked to return to the dentist 2 days after the original therapy. Typically the patient is much improved. If therapy is successful, swelling and pain decreases dramatically. The dentist should check the I&D site to determine whether the drain should be removed at this time. Other parameters, such as temperature, trismus, swelling, and the patient's subjective feelings of improvement, should also be investigated.

If there is not an adequate response to treatment, the patient should be examined carefully for clues to the reason for failure (Box 15-7). The most common cause of treatment failure is inadequate surgery. A tooth may have to be reevaluated for extraction, or a fluctuant area not obvious at the first treatment may have to be incised.

BOX 15-7

Reasons for Treatment Failure

- Inadequate surgery
- Depressed host defenses
- Foreign body
- Antibiotic problems
- Patient noncompliance
- Drug not reaching site
- Drug dose too low
- Wrong bacterial diagnosis
- Wrong antibiotic

A second reason for failure is depressed host defense mechanisms. A review of the patient's medical history should be performed and more careful probing questions asked. Local defense mechanism depression by things such as dehydration and pain should also be considered and corrected if necessary.

A third reason for treatment failure is the presence of a foreign body. Although this is unlikely in an odontogenic infection, the dentist may consider taking a periapical radiograph of the area to help ensure that a foreign body is not present.

Finally, there may be problems with the antibiotic that was given to the patient. The dentist first ascertains if the patient has been compliant. The patient must have the prescription filled and take the antibiotic according to directions. Many patients fail to follow the orders of their dentists as carefully as they should. Another problem to consider is whether the antibiotic reached the infected area. Failure to reach the area may be related to inadequate surgery, inadequate blood supply to the local area, or a dose that is too low to be effective against the bacteria. Another antibiotic-related problem is an incorrect bacterial diagnosis. If a culture was not performed at the initial surgical treatment or if no surgical treatment was done at the initial therapy, the dentist should obtain a pus specimen for culture and antibiotic sensitivity testing. Finally, it is possible that the wrong antibiotic was prescribed for the infection, which may be because of an inaccurate bacterial diagnosis or an unusual antibiotic resistance of typical bacteria. For example, *Prevotella* organisms are usually resistant to penicillin, but rarely cause persistent infection if penicillin is given and surgery is done. However, if the patient has a persistent, low-grade infection that does not resolve, prescribing an antianerobic antibiotic such as clindamycin would be appropriate.

The clinician must also examine the patient to look specifically for toxicity reactions and untoward side effects. Patients may report complaints such as nausea and abdominal cramping but may fail to associate watery diarrhea with the drug administration. Specific questioning about the expected toxicities is important to their early recognition.

The dentist should also be aware of the possibility of secondary or superinfections. The most common secondary infection encountered by dentists is oral or vaginal candidiasis. This is the result of an overgrowth of *Candida* organisms, because the normal oral flora has been altered by the antibiotic therapy. Other secondary infections may arise as normal host flora is altered, but they are not seen with any degree of frequency in the management of odontogenic infections.

Finally, the dentist should follow the patient carefully once the infection has resolved, to check for recurrent infection. This would be seen in a patient who had incomplete therapy for the infection. A variety of reasons may account for this. For example, the patient may have stopped taking the antibiotics too early. The drain may have been removed too early and the drainage site sealed too early, which reestablished the infectious process. If infection does recur, surgical intervention and reinstitution of antibiotic therapy should be considered.

PRINCIPLES OF PREVENTION OF INFECTION

The use of antibiotics to treat an established infection is a well-accepted and well-defined technique. These drugs provide major assistance for the patient in overcoming an established infection. The use of antibiotics for prevention (i.e., prophylaxis) of infection is also clearly established but less widely accepted. The final section of this chapter discusses the use of antibiotics for prophylaxis of two distinct types of infection. The use of antibiotics to prevent wound infection after surgery is presented first, followed by a discussion of their use to prevent metastatic infection.

PRINCIPLES OF PROPHYLAXIS OF WOUND INFECTION

The use of antibiotics for prophylaxis of postoperative wound infections can be highly effective and desirable in certain situations. The advantages of the appropriate use of prophylactic antibiotics are clear. First of all, prophylactic antibiotics reduce the incidence of patient infection and thereby reduce postoperative patient morbidity. When a patient becomes infected after surgery, wound healing and recovery are substantially delayed. Second, appropriate and effective antibiotic prophylaxis reduces the cost of health care. By decreasing the incidence of postoperative infection, the patient is saved the additional expense of returning to the dentist, buying additional antibiotics, and missing additional days of work. Third, appropriate use of prophylactic antibiotics requires a shorter-term administration than therapeutic use, thereby decreasing the total amount of antibiotics used by the population. Finally, fewer opportunities exist for resistant bacteria to arise when effective prophylactic antibiotics are used.

The use of prophylactic antibiotics also has several disadvantages: First, they may alter host flora. The body is populated with a variety of bacteria that have a symbiotic relationship with the host. When antibiotics are administered, some of these bacteria are eliminated, allowing the overgrowth of antibiotic-resistant and perhaps more pathogenic bacteria that may then cause infection. Second, the antibiotic may provide no benefit, which means that in certain situations the risk of infection is so low that the antibiotic provides no additional decrease in the incidence of infection. Third, the use of prophylactic antibiotics may encourage lax surgical technique on the part of the dentist.

The attitude of, "Oh well, the patient is on antibiotics," may become an excuse when principles of surgery are violated. Fourth, the cost of the antibiotic must be considered. Although for a single event for a single patient the cost may be small, the cost for many surgeries for many patients can be enormous. Finally, the toxicity of the drug to the patient must be also kept in mind. All drugs have the potential to cause injury to the patient. Although most antibiotics used by dentists have low toxicity, the possibility of toxicity is always present. The principles of prophylactic antibiotic use are summarized in Box 15-8.

BOX 15-8

Principles of Prophylactic Antibiotic Use

- Risk of infection must be significant
- Correct antibiotic must be chosen
- Antibiotic level must be high
- Antibiotic must be timed correctly

BOX 15-9

Factors Related to Postoperative Infection

- Size of bacterial inoculum
- Extent and time of surgery
- Presence of foreign body
- State of host resistance

Principle I: Procedure Should Have Significant Risk of Infection

For prophylactic antibiotics to reduce the incidence of infection, the surgical procedure must have a high enough incidence of infection to be reduced with antibiotic therapy. Clean surgery done with strict adherence to basic surgical principles usually has an incidence of infection of about 3%. Infection rates of 10% or more are usually considered unacceptable, and the use of prophylactic antibiotics must be strongly considered. For the dentist doing routine office surgery, this means that most office procedures performed on healthy patients do not require prophylactic antibiotics. The incidence of infection after tooth extraction, frenectomy, biopsy, minor alveoloplasty, and torus reduction is extremely low; therefore antibiotics would provide no benefit.

However, several surgical factors may influence the dentist to consider strongly the use of antibiotic prophylaxis (Box 15-9): The first and most obvious factor that may lead to infection is a bacterial inoculum of sufficient size. The usual surgical procedure performed in the mouth rarely involves sufficient bacterial inoculation to cause infection. The second factor is surgical procedures that are rather extensive and require prolonged surgery. The incidence of infection increases both with the extent of surgery and with longer surgical procedures. A third factor that may suggest the use of antibiotics is the insertion or presence of a foreign body, most commonly a dental implant. Most data seem to suggest that the use of antibiotics may decrease the incidence of infection when foreign bodies, such as dental implants, are inserted into the jaws.

The final and most important factor for most dentists in determining which patients should receive prophylactic antibiotics is whether the patient has depressed host defenses. Patients who have a compromised ability to defend themselves against infection should probably receive prophylactic antibiotics because they are likely to have a higher incidence of more severe infection. All patients receiving cancer chemotherapy or immunosuppressives should receive prophylactic antibiotics, even when minor surgical procedures are performed. Patients receiving immunosuppressives for organ transplant will be taking these drugs for the remainder of their lives and should be given preventive antibiotics accordingly. Patients receiving cancer chemotherapy will receive cytotoxic drugs for 1 year or less but should be given prophylactic antibiotics for at least 1 year after the cessation of their chemotherapy.

Principle II: Choose Correct Antibiotic

The choice of antibiotic for prophylaxis against infections after surgery of the oral cavity should be based on the following criteria. First, the antibiotic should be *effective* against the organisms most likely to cause the infection in the oral cavity. As previously discussed, the aerobic streptococci are almost always the original causative organism of oral infection. Second, the antibiotic chosen should be a *narrow-spectrum* antibiotic.

By using a narrow-spectrum antibiotic, the disadvantage of altering host flora is minimized. Third, the antibiotic should be the *least toxic* antibiotic available for the patient. Finally, the drug selected should be a *bactericidal* antibiotic. Because many of the routine uses of prophylactic antibiotics in the dental office will be for patients with compromised host defenses, it is important that the antibiotic effectively kill the bacteria.

Taking into account these four criteria, the antibiotic of choice for prophylaxis after oral surgery is penicillin. It is effective against the causative organism (i.e., *Streptococcus*), is narrow-spectrum, has a low toxicity, and is bactericidal. For patients who have had mild allergic reactions to penicillin, the drug of choice is a cephalosporin, such as cefadroxil. It is effective, nontoxic, and bactericidal, but it is a broader-spectrum antibiotic, which makes it the second-choice drug. The third choice is clindamycin. It is effective, narrow-spectrum, but it is less effective against streptococci. The last choice for oral administration for prophylaxis is clarithromycin. It is reasonably effective against the usual organisms and is narrow-spectrum, but it is bacteriostatic.

Principle III: Antibiotic Plasma Level Must Be High

When prophylactic antibiotics are used, the antibiotic level in the plasma must be higher than when therapeutic antibiotics are used. The peak plasma levels should be high to ensure diffusion of the antibiotic into all fluid and tissue spaces where the surgery is going to be performed. The usual recommendation for prophylaxis is that the drug be given in a dose at least *2 times* the usual therapeutic dose. For penicillin this would mean at least 1 g; for the cephalosporins, such as cefadroxil, it would be 1 g; for clindamycin, at least 300 mg; and for clarithromycin, 500 mg.

Principle IV: Time Antibiotic Administration Correctly

For the antibiotic to be maximally effective in preventing postoperative infection the antibiotic must be given *before* the surgery begins. This principle has been clearly

established in many animal and human clinical trials. Antibiotic administration that occurs after surgery either is markedly decreased in its efficacy or has no effect at all on preventing infection.

If the surgery is prolonged and an additional antibiotic dose is required, intraoperative dose intervals should be shorter (i.e., one half the usual therapeutic dose interval). Therefore penicillin should be given every 2 hours, cephalexin every 2 hours, and clindamycin every 3 hours. This ensures that the peak plasma levels will stay adequately high and avoids periods of inadequate antibiotic levels in the tissue fluids.

Principle V: Use Shortest Antibiotic Exposure That Is Effective

For the antibiotic prophylaxis to be effective, the antibiotic must be given before the surgery begins, and adequate plasma levels must be maintained during the surgical procedure. Once the surgical procedure is completed, continued antibiotic administration produces no benefit. Therefore the final dose of the antibiotic is usually given after the surgical operation. If the procedure is a short operation, a single preoperative dose of antibiotics is adequate. If the surgery lasts for 1 to 2 hours, the surgeon should give a second dose of antibiotics before the patient leaves the office. A plethora of animal and human clinical data demonstrates that the use of prophylactic antibiotics is necessary only for the time of surgery; after closure of the wounds and formation of the blood clots, migration of bacteria into the wound and underlying tissues occurs at such a low level that additional antibiotics are not necessary.

Summary

The use of antibiotics for prophylaxis of postoperative wound infection can be very effective. It reduces patient pain, morbidity, cost, and total antibiotic use. Appropriate antibiotic prophylaxis does little to alter host flora and does not encourage resistant bacteria. Most dental procedures on healthy patients do not require antibiotic prophylaxis. A few select patients who are to undergo extensive or long surgical procedures or the insertion of foreign bodies, such as dental implants, should be considered for prophylaxis. Patients who have compromised host defenses because of poorly controlled metabolic diseases or certain diseases that interfere with defenses or who are taking drugs that interfere with host defenses should also be given prophylactic antibiotics. The drug of choice is a narrow-spectrum antibiotic that is effective against causative organisms, is nontoxic, and is bactericidal. Penicillin fits these criteria the best.

When the antibiotic is given, it should be begun before the surgery begins, at a normal dose twice that of therapeutic antibiotics. If the surgery is prolonged, interim doses of half the normal dose interval should be used. High plasma levels should be maintained during the surgical procedure, but no additional antibiotics are necessary after surgery. A common practice is to provide a second and final dose of antibiotic at the termination of the surgery before the patient leaves the office.

BOX 15-10

Factors Necessary for Metastatic Infection

- Distant susceptible site
- Hematogenous bacterial seeding
- Impaired local defenses

PRINCIPLES OF PROPHYLAXIS AGAINST METASTATIC INFECTION

Metastatic infection is defined as infection that occurs at a location physically separate from the portal of entry of the bacteria. The classic and most widely understood example of this phenomenon is bacterial endocarditis, which arises from bacteria that can be introduced into the circulation as a result of tooth extraction. The incidence of metastatic infection can be reduced if antibiotic administration is used to eliminate the bacteria before they can establish an infection at the remote site.

For metastatic infection to occur, several conditions must be met (Box 15-10). The first and most important is that there must be a susceptible location in which an infection can be established. The deformed heart valve with its altered endothelial surface onto which a sterile vegetation has formed is an example of this.

There also must be bacterial seeding of the susceptible area. This seeding occurs as the result of a bacteremia in which bacteria from the mouth are carried to the susceptible site. Most likely, a quantitative factor is involved in this seeding process, because the body has multiple episodes of small bacteremias as a result of normal daily activities. More than likely, bacteremias with large quantities of bacteria are necessary to produce metastatic infection. The duration of the bacteremia may also play a role. In some situations (e.g., total joint replacement) a prolonged high-level bacteremia, or septicemia, is usually necessary to establish a metastatic infection. It is important to remember that the bacteremia after oral surgery is usually completely eliminated by the body's reticuloendothelial system within 15 minutes after completion of the surgery.

Also necessary for the establishment of metastatic infection is some impairment of the local host defenses. Once bacteria have attached to a cardiac vegetation, they are protected from white blood cell phagocytosis by a thin coating of fibrin. Bacteria that are in close proximity to foreign bodies, such as implants, may not be easily phagocytized by white blood cells, and small numbers of bacteria may be able to establish an infection.

Prophylaxis Against Infectious Endocarditis

Infectious endocarditis may be caused by bacteria that was introduced into the circulation as a result of oral surgery and that attached to sterile vegetation that exists on an abnormal heart valve. This vegetation can arise because of the turbulent flow around an incompetent heart valve. The turbulent flow causes loss of the surface endocardium, which exposes the underlying collagen. Platelets aggregate

on the exposed collagen and, together with precipitated fibrin, form a sterile fibrin-platelet thrombus called a *vegetation.* This vegetation presents no problems to the patient until it becomes infected with bacteria and produces bacterial endocarditis. When this occurs the patient must be treated in the hospital with high doses of intravenous (IV) antibiotics for prolonged periods. Although initial recovery from bacterial endocarditis approaches 100%, recurrent episodes reduce the 5-year survival rate of patients with this disease to approximately 60%.

Bacterial endocarditis resulting from introduction of bacteria from an oral source is almost exclusively the result of alpha-hemolytic streptococci with typical antibiotic sensitivity patterns. Prophylaxis regimens against bacterial endocarditis after dental procedures are directed toward effective killing of *Streptococcus* organisms. The goals of antibiotic prophylaxis in this case are to reduce the intensity of the bacteremia, assist the reticuloendothelial system in killing the bacteria, and decrease the bacterial adherence to the damaged heart valves and vegetations.

The American Heart Association has had formal recommendations for the prevention of bacterial endocarditis after dental treatments since 1960. The latest formal recommendations appeared in June 1997.

When treating patients surgically, it is important that the dentist specifically inquire about cardiac valvular lesions that may predispose the patient to bacterial endocarditis (Box 15-11). Antibiotic prophylaxis should be used when a dental procedure is performed that will produce bleeding of the mucosa. Some procedures, such as tooth extraction and periodontal surgery, obviously cause bacteremias; however, vigorous dental prophylaxis should also be included in this category (Box 15-12). Some procedures, such as supragingival tooth cleaning, placement and adjustment of orthodontic appliances, typical restorative tooth preparation procedures, and conservative nonsurgical endodontic therapy, do not require antibiotic prophylaxis (Box 15-13). These procedures do not cause bacteremias of sufficient intensity to predispose the patient to endocarditis.

Bacterial endocarditis prophylaxis is achieved for most routine conditions with the administration of 2 G of amoxicillin 1 hour before the procedure (Table 15-4). Amoxicillin is the drug of choice, because it is better absorbed from the gastrointestinal tract and provides higher and more sustained plasma levels. Amoxicillin is an effective killer of alpha-hemolytic streptococcus (i.e., *Streptococcus viridans*), which is the organism that most commonly causes endocarditis after dental procedures. The decision to recommend amoxicillin was not made to provide a broader antimicrobial spectrum.

For patients who are allergic to penicillin, two alternative drugs have been recommended. The first recommended drug is clindamycin, with a dose of 600 mg orally 1 hour before the surgery. If the patient's allergy to penicillin is mild and not of an anaphylactic type, first-generation cephalosporin can be prescribed. Either cephalexin or cefadroxil is recommended. Although erythromycin is no longer recommended, the newer macrolide antibiotics, azithromycin or clarithromycin, are acceptable alternative drugs. Their chief disadvantage is that they are more expensive than the other regimens. If the patient is unable to take oral medication, parenteral administration can be used.

For the pediatric patient, the dose of the drugs that are given must be reduced. The recommendations include clear guidelines for these reductions (see Table 15-4).

BOX 15-11

Cardiac Conditions Associated With Endocarditis

High-Risk Category—Prophylaxis Recommended
- Prosthetic cardiac valve
- Previous bacterial endocarditis
- Complex cyanotic congenital heart disease
- Surgically constructed systemic pulmonary heart

Moderate-Risk Category—Prophylaxis Recommended
- Most other congenital malformations
- Acquired valvar dysfunction
- Hypertropic cardiomyopathy
- Mitral valve prolapse with valvar regurgitation

Negligible-Risk Category—Prophylaxis NOT Recommended
- Isolated secundum atrial septal defect
- Surgical repair of atrial septal defect; patient ductus arteriosus
- Coronary artery bypass graft
- Mitral valve prolapse without regurgitation
- Physiologic, functional, or innocent heart murmur
- Previous rheumatic fever with valvar dysfunction

BOX 15-12

Dental Procedures in Which Prophylaxis Is Recommended

- Dental extractions
- Periodontal procedures
- Dental implant placement
- Periapical endodontic procedures
- Initial placement of orthodontic bands but not brackets
- Intraligamentary local anesthetic injections
- Dental prophylaxis when bleeding is expected

BOX 15-13

Dental Procedures in Which Prophylaxis Is NOT Recommended

- Restorative dentistry
- Routine local anesthetic injection
- Intracanal endodontic therapy
- Suture removal
- Placement of removable appliances
- Making impressions

Some patients at risk for bacterial endocarditis will be taking daily doses of penicillin to prevent recurrence of rheumatic fever or taking an antibiotic for other reasons. In these patients the streptococci may be relatively resistant to penicillin. The recommendation is that the dentist should use clindamycin, azithromycin, or clarithromycin for endocarditis prophylaxis. The cephalosporins should be postponed because of possible cross-reference. If possible, the procedure should be postponed until 9 to 14 days after the antibiotic is completed, thus allowing normal oral flora to be reestablished.

If a particular patient requires a series of dental treatments that requires antibiotic prophylaxis, a period of 9 to 14 days between appointments is recommended. The reason for the interval is that the administration of antibiotics for several days or more continuously may allow the overgrowth of oral streptococci, which are resistant to the antibiotic being given, thus making prophylaxis more likely to fail. The 9- to 14-day antibiotic-free period allows recovery to antibiotic-sensitive organisms.

Occasionally. unexpected bleeding may occur during dental treatment in a patient who is at risk for endocarditis. In this situation appropriate antibiotic prophylaxis should be administered as soon as possible, but definitely within 2 hours. Prophylaxis given longer than 4 hours after the bacteremia may have more limited prophylactic benefit.

Patients at risk for bacterial endocarditis should have a comprehensive prophylaxis program that includes excellent oral hygiene with excellent periodic professional care. Special care should be taken for the establishment of an effective preventive program, and all incipient dental and periodontal disease should be treated. If surgery is required, the dentist should do everything possible to keep the size of the bacteremia as small as possible. Two steps can be taken: First, the extent of the surgical procedure can be limited, which can be done by dividing the surgical procedure into two or three appointments rather than doing all of the indicated surgery at the same time. For example, if the patient requires the removal of 10 teeth, the dentist can remove three or four in each of three appointments. Second, the mouth should be rinsed preoperatively with an antibacterial agent, such as chlorhexidine. If fewer bacteria exist on and around the teeth during the surgical procedure, there will be a less intense bacteremia.

Finally, it is important for the dentist to understand that even when appropriate measures are taken to prevent bacterial endocarditis, it may still occur. Patients should be informed of this and advised to return to the dentist or to their regular physician if any of the signs and symptoms of bacterial endocarditis, especially fever and malaise, occur.

Prosthetic valve endocarditis occurs when the tissue around the cardiac valve implant becomes infected. Such infections are caused by the same bacteria that cause typical native valve endocarditis. Prosthetic valve endocarditis is a much more serious illness than native valve endocarditis, because the loosening of the heart valve may result in death. The 1-year survival rate for patients who have prosthetic valve endocarditis is about 50%. The American Heart Association currently recommends that the standard 2 G of amoxicillin regimen is adequate for most patients with prosthetic heart valves.

Prophylaxis in Other Cardiovascular Cases

Several other cardiovascular conditions require the clinician to consider the administration of prophylactic antibiotics for the prevention of metastatic infection. In *coronary artery bypass grafting* (CABG), the coronary arteries are reconstructed with vein grafts. Because CABG does not predispose patients to metastatic infection, these patients should not be given prophylactic antibiotics before a dental procedure is performed.

TABLE 15-4

Antibiotic Regimen for Prophylaxis of Bacterial Endocarditis

Situation	Antibiotic	Regimen
Standard prophylaxis	amoxicillin	Adults: 2 G orally 1 hr before procedure Children: 50 mg/kg orally 1 hr before procedure*
Penicillin allergic	clindamycin OR arithromycin OR clarithromycin	Adults: 600 mg orally 1 hr before procedure Children: 20 mg/kg orally 1 hr before procedure* Adults: 500 mg orally 1 hr before procedure Children: 15 mg/kg orally 1 hr before procedure*
Unable to take oral medication	ampicillin	Adults: 2 G IM or IV within 30 min before procedure Children: 20 mg/kg IV within 30 min before procedure*
Unable to take oral medication and penicillin allergic	clindamycin OR cefazolin	Adults: 600 mg IV within 30 min before procedure Children: 20 mg/kg IV within 30 min before procedure* Adults: 1 G IM or IV within 30 min before procedure Children: 25 mg IM or IV within 30 min before procedure*

*Total children's dose should not exceed adult dose.

IM, Intramuscularly; *IV,* intravenously.

BOX 15-14

Conditions Placing Patients at Risk for Prosthetic Joint Infection

- Immunosuppression
- Rheumatoid arthritis
- Systemic lupus erythematosus
- Insulin-dependent diabetes
- Previous prosthetic joint infection
- Prosthetic joint within 2 years

BOX 15-15

Procedures That Require Prophylaxis

- Dental extractions
- Implant placement
- Periodontal procedures
- Periapical surgery
- Initial placement of orthodontic bands
- Intraligamentary local anesthetic injections

Patients with a transvenous pacemaker have a battery pack implanted in their chests, with a thin wire that runs through the superior vena cava into the right side of the heart. These patients usually do not require prophylactic antibiotics when dental procedures are performed. However, consultation with the patient's cardiologist may be used to confirm that this is the best management.

Patients on renal dialysis frequently have an arteriovenous shunt appliance implanted in their forearms to provide the dialysis team ready access to the bloodstream. Metastatic infection may occur in these shunts after bacteremia. These are usually caused by staphylococci and not oral bacteria. Therefore antibiotic prophylaxis is not usually necessary. However, the dentist should contact the patient's nephrologist or renal dialysis team to discuss the best management.

Patients who have hydrocephaly may have decompression with ventriculoatrial shunts. Because these shunts may induce valvular dysfunction, antibiotic prophylaxis may be required. Consultation with the patient's neurosurgeon should be considered.

Patients who have had severe atherosclerotic vascular disease and have had alloplastic vascular grafts placed to replace portions of their arteries may be at risk for metastatic infection. After the vascular implant is in place, the interior of the graft undergoes endothelialization, a process that usually requires approximately 3 to 6 months. Until this process is complete, the alloplastic vascular implant is exposed in the lumen of the vessel. Potentially a bacteremia of oral origin could seed the implant and cause infection. Therefore prophylactic antibiotics should be strongly considered during the first 6 months. After a 6-month interval, prophylactic antibiotics are usually not indicated. The dentist should consider consultation with the patient's vascular surgeon before performing extensive dental surgery.

Prophylaxis Against Total Joint Replacement Infection

Patients who have undergone total replacement of a joint with a prosthetic joint may be at risk for hematogenous spread of bacteria and subsequent infection. These late prosthetic joint infections result in severe morbidity, because the implant is usually lost when infections occur. There has been great concern that the bacteremia caused by tooth extraction may result in such infections. However, the recent literature suggests that bacteremias from oral procedures do not cause prosthetic joint infections. It appears that the bacteremia after oral surgery is of a transient nature and does not expose the implant and periimplant tissues to bacteria long enough to cause infection.

Instead it appears that the hematogenous spread of prosthetic joint infections is caused by chronic infections elsewhere in the body that result in chronic septicemias. These infections are typically urinary tract infections, pulmonary infections, and skin infections, but established odontogenic infections may also cause a septicemia of sufficient magnitude to cause a total joint infection.

In July of 1997 the American Dental Association (ADA) and the American Academy of Orthopedic Surgeons (AAOS) issued a joint recommendation concerning the management of patients with prosthetic total joints. The recommendations of the ADA and AAOS recognize that most patients with a prosthetic joint are not at risk for joint infection after a dental surgical procedure. Instead the guidelines identify the high-risk patients who are potentially susceptible to such infections (Box 15-14). Likewise, it identifies those procedures that are most likely to cause joint infections and therefore require prophylaxis (Box 15-15). Finally, the joint statement recommends a specific antibiotic recommendation to help prevent infection in the susceptible patient who is undergoing one of the procedures that require prophylaxis (Table 15-5).

When the dentist decides to provide antibiotic prophylaxis for a patient, the recommended antibiotics are first-generation cephalosporin and ampicillin. For patients who are allergic to penicillin, clindamycin is recommended. As with bacterial endocarditis prophylaxis, only a single preoperative dose is recommended, with no follow-up doses. If patients are unable to take oral medication, a parenteral regimen is also suggested (Box 15-16).

If a patient who has a total joint replacement needs treatment of an infection, aggressive therapy for the infection is necessary to prevent seeding of the bacteria, causing odontogenic infection to the prosthetic joint. This aggressive treatment should include extraction, I&D, and the use of high-dose bactericidal antibiotics, probably given IV. The clinician should strongly consider performing C&S testing, because if a prosthetic joint infection does occur, it would be useful to know which bacteria is likely the culprit and its antibiotic sensitivity.

TABLE 15-5

Antibiotic Regimen for Prophylaxis of Total Joint Replacement Infection

Regimen	Drug	Dose
Standard oral prophylaxis	First generation cephalosporin OR Amoxicillin	2 G 1 hr before procedure 2 G 1 hr before procedure
Penicillin allergic oral prophylaxis	Clindamycin	600 mg 1 hr before procedure
Parenteral prophylaxis	Cefazolin OR Ampicillin	1 G IV within 1 hr of procedure 600 mg IV within 1 hr of procedure

IV, Intravenous.

BOX 15-16

Indication for Parenteral Regimen

- Patient to have general anesthetic and NPO
- Unable to take oral medications
- High-risk patients, such as those with history of previous bacterial endocarditis

NPO, Nothing by mouth.

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